we learn that Alkhojandi, about 1000 A.D., discovered that the equation $x^3 + y^3 = z^3$ does not admit of rational solutions.

A brief outline of the period 1200–1500 brings this excellent book to its conclusion. That it is the outcome of independent and careful research is evident; and the reader's appreciation of this fact is rather enhanced than otherwise by Dr. Zeuthen's graceful acknowledgment of his obligations to his predecessors in the same field, more particularly to Cantor and Tannery.

Mr. Ball's "Primer" is a work of a very different scope. Its object is "to give a popular account of the history of mathematics, including therein some notice of the lives and surroundings of those to whom its development is mainly due, as well as of their discoveries." It is expressly said that it is not intended for those to whom the subject is familiar. The plan adopted is to give a series of brief biographies in chronological order, interspersed with occasional paragraphs on particular periods. The necessary element of "human interest" is supplied by a number of anecdotes. Many of these are pertinent enough; others are certainly superfluous. Why should half a page be devoted to the unhappy matrimonial experiences of Kepler? or, again, what is the value of the information that Descartes in Paris was "modestly clad in green taffety?"

Still, the book is entertaining, and, although very sketchy, fulfils its purpose well enough until we come to the last section, which treats of recent mathematics. Here the difficulties of the subject, and the narrow limits of his plan, have been too much for the author. That this should be the case is not altogether surprising; but some of the faults of omission and commission are too serious to be passed over.

Thus in the paragraph on Cauchy, no mention is made of his work on the theory of numbers, or of his great memoir on waves. The statement that "the rule for finding the principal values of integrals was enunciated by him and the calculus of residues was his invention," is much as if one should say "Newton discovered the binomial theorem and wrote the 'Principia.'" Worst of all, the account concludes with the remark: "In many of his memoirs the feverish haste with which they were thrown off is too visible, and several are marred by obscurity, repetition of old results, and blunders." Such criticism of a great genius is in questionable taste, and is apt to recoil on the person who makes it. It seems to us rather obscure to say (p. 132) that "in this theory the theta-functions are independent of the form of their space-boundaries"; and that Eisenstein "considered the theorems relating to the possibility of representing a number as a sum of squares, and showed that the general theorem was limited to eight squares." Will not the general reader infer from this that no number is the sum of more than eight squares?

Then as to inadvertent errors (it would be unkind to call them blunders): (1) it is not true that "the only regular polygons which can be constructed by elementary geometry are those of which the number of sides is $2^m (2^n + 1)$, where m and n are integers and $2^n + 1$ is a prime"; even Euclid could construct a regular quindecagon; (2) the theory of ternary quadratic forms is not due to Eisenstein; (3) Eisenstein did not give a rule for distinguishing whether a given series represents an algebraical or a transcendental function (see Heine's "Kugelfunctionen," 2nd edition, i. p. 50); (4) Abel did not prove that it is impossible to solve a quintic equation by means of radicals, but the quite different proposition that a root of the *general* quintic cannot be expressed in terms of its coefficients by means of radicals.

Finally, the omission of all notice of Galois is entirely inexplicable. The pathetic story of his death appeals to universal sympathy, and might even draw a tear from the hardened general reader; while the influence of his work upon recent analysis is, perhaps, second only to that of Riemann.

Fault-finding is not pleasant, and is apt to bulk too largely in a review. Mr. Ball's readers may not be impressed by the fact that Cayley "introduced the so-called 'absolute,'" and they may be inclined to think that "homaloidal hyper-space" is a somewhat technical expression; but they will find plenty of amusement in the "Primer," and a good deal of instructive reading; while, for reasons which are different, but each sufficient, the occasional *lapsus calami* will do neither the instructed nor the uninstructed reader any harm.

G. B. M.

THE SPIDERS OF BURMA.

Descriptive Catalogue of the Spiders of Burma, based upon the Collection made by Eugene W. Oates, and preserved in the British Museum. By Dr. T. Thorell (London: printed by order of the Trustees, 1895.)

DURING his residence in British Burma, in the capacity of civil engineer, Mr. E. W. Oates availed himself of the rare opportunities of travelling, afforded by his official duties, to investigate certain portions of the fauna of the country, choosing as objects of special study such diverse groups as Scorpions, Whip-Scorpions, and Spiders; Centipedes and Millipedes; and Birds. It was, we believe, primarily his intention to work out all his collections himself upon his return to England on furlough. In fact, while still in the East he published, in the *Journal of the Asiatic Society of Bengal*, descriptions of his new species of Whip-Scorpions (*Thelyphonus*), and shortly after his arrival, his paper upon the Indian and Burmese species of Scorpions of the genus *Isometrus* appeared in the *Journal of the Bombay Natural History Society*. But further than this, his studies in the invertebrate portion of his material did not go; and realising the impossibility of grappling in the space of time at his disposal with the vast number of species of spiders and myriapods that he had procured, he generously presented these in their entirety to the Trustees of the British Museum, and devoted his energies to the study of the Birds of British India and Burma, of which he had already acquired considerable knowledge. In the course of the next few years, the Centipedes and Millipedes were determined and reported upon in a series of memoirs that appeared in the *Annali del Museo Civico di Genova*. The spiders, however, were, at Mr. Oates's request, submitted for examination to Dr. T. Thorell, who had already made himself an authority upon Burmese Arachnida, in connection with the study of the material of this group amassed under the auspices of the Marchese G. Doria by that practised collector, Sig. L. Fea. But although the Italians, in the persons of Sigg. Fea and Comotto, had had the first bite at the Burmese Arachnid fauna, the careful sorting and examination of Mr. Oates's collection soon showed that this gentleman had more than doubled the number of known Burmese spiders. For whereas only 175 species had been previously recorded, the total number now amounts to no less than 381. Mr. Oates's collection thus contains 206 species that are new to Burma, and of these 153 appear to be new also to science. It comprises, moreover, either the males or females of many species of which only one sex had been hitherto described.

The secret of Mr. Oates's success as a collector of spiders is to be attributed partly, of course, to his paying special attention to them, but largely to his ingenious mode of attracting them. He tells us that—

> "The greater part of the collection was made at Tharrawaddy [a station about seventy miles north of Rangoon], where I had a large garden, and a portion of it was specially prepared for the attraction of spiders, which came to it in large numbers. I put in plants of those species which my experience told me were specially affected by spiders, and by this means I was able to observe very many species in a small compass. By carefully watching the females for some weeks, I generally contrived to secure the males in such a manner as to render their identification with their respective females certain. In addition to the garden, there were large forests not far from my house. I collected at all seasons of the year, but I found the rains, from May to October, most productive. I was greatly assisted by my wife, who soon overcame her natural repugnance to spiders, and handled them freely."

With such exceptional opportunities of observation at his command, it is a matter for regret that Mr. Oates made so few notes upon the bionomics of the species he collected. For it is no exaggeration to say that if records had been kept in the case of each species of its habitat, and method of courtship and of the structure of its cocoon and snare, the value and interest of the collection would have been greatly enhanced. In the case, however, of *Herennia multipuncta*, an Epeiroid allied to *Nephila* and *Argiope*, and widely distributed in the Oriental region, Mr. Oates made the following observation :

> "Makes a web about three feet long on a smooth tree-trunk, width one-third or one-fourth of girth of tree. All the lines are vertical or horizontal, forming a perfect rope-ladder. The web follows the convexity of the trunk, and is everywhere about half-inch from it. Verticals about one inch apart, horizontals about quarter of an inch apart."

With justice does Thorell term this : "annotatiunculam magni momenti," and add "rete formæ adhuc plane ignotæ igitur facit, *Herennia multipuncta*"! Curiously enough, however, M. Simon asserts that this same species, as observed by him in Ceylon, makes a snare, as indeed one would have supposed to be the case, of the ordinary orbicular type. We are consequently at a loss to know quite what value is to be attached to Mr. Oates's statement.

Turning to the spiders themselves, perhaps the only one amongst the new genera and species that calls for special mention is the remarkable new form *Prolochus longiceps*, which although presenting many points of similarity to the familiar epeiroid, *Meta segmentata*, differs from all the orb-spinners that have been hitherto described, in having only six large eyes and the cephalic region of the carapace very high and long. In this last respect it somewhat resembles the spider named *Archæa*, which was described by Koch and Berendt from the Oligocene amber beds of the Baltic. Thorell consequently refers it, although provisionally, to the Archæidæ (written by him Archæoidæ), and classes the family with the Retitelariæ, although for what reason does not appear. Probably the best way of disposing of the difficulty would have been the establishment of a new family for the reception of this anomalous spider.

So far as the rest of the genera and species are concerned, there appears to be nothing particularly remarkable in the collection, excepting only the new genus of Attidæ named *Ligdus*, which in its flattened form and the position of its enlarged first pair of legs presents a strongish superficial resemblance to one of the False-Scorpions (*Pseudoscorpiones*).

Most persons who glance through this book will probably be surprised and disappointed to find that the 400 pages of letterpress are relieved by no illustrations ; but those who are familiar with the rest of Dr. Thorell's works, will know what they have to expect on this head. The lack of figures, however, is made good, as far indeed as is possible, by the fulness of the specific descriptions, which often run to more than two pages of print. Some, perhaps, may be disposed to think these descriptions are unnecessarily long ; but on such a point, Dr. Thorell's opinion is probably of greater value than that of any other person : and it is only fair to him to mention that, in addition to the description, a briefer diagnosis of each species is subjoined, so that the attempt to identify a species does not necessarily entail a large amount of fruitless reading. We greatly regret, however, the author's stern adherence to the practice of not compiling synopses of his species. For there is nothing like a carefully compiled synoptical table for bringing home to an author and his readers the essential characteristics of the species being dealt with.

In the introduction Dr. Thorell takes the opportunity of explaining his opinions upon some of the many vexed questions connected with zoological nomenclature. But although we find it impossible to agree with all that he holds, the views of such an accomplished linguist are worthy of the greatest attention, especially where questions of philology are concerned ; and we earnestly commend them to the notice of those who in the construction and adoption of zoological names wantonly violate every canon of etymology, until "it seems as if neither common sense nor the dignity of science can claim any rights against the whims, carelessness, or ignorance of certain authors." Speaking, for instance, of the adoption without alteration of ungrammatically formed specific names, Dr. Thorell says :

> "It is an essential rule in the Linnæan system that the scientific names of plants and animals shall be in *Latin*, at least as to their form. Now as a great number of specific names consist of the genitive of personal proper names, that genitive should, when possible, be formed in analogy with the genitive of Latin names or other words of a similar form. The genitive, for instance, of Caligula,

Livius, and Catullus being *Caligulæ*, *Livii*, and *Catulli*, I cannot accept such specific names as *Doriai*, *Retziusi*, *Catulloi*, but consider that they should be corrected to *Doriæ*, *Retzii*, *Catulli*."

With regard to genera, Dr. Thorell considers that such terms as *Scorpio* and *Aranea*, cannot be used in a generic sense, because in the plural form they are applied respectively to the orders of Scorpions and Spiders. This view, however, is, we venture to think, untenable. For the terms were used by Linnæus generically before they were used ordinally; therefore, if it be considered necessary to change either the generic or the ordinal name, it is surely the latter that should be abolished. Moreover, in the interests of nomenclature it is more important that the generic name should be stable than the other. And curiously enough, Dr. Thorell, with apparent inconsistency, seems to take this view of the case when there is any clashing between the name of a family and of one of its genera. For he always, and we believe correctly, forms he family-names with the termination—oidæ, such as Lycosoidæ instead of the more usually accepted Lycosidæ. But he affirms that if there be a genus termed *Lycosoides* contained in the family Lycosoidæ, the latter name must be altered, and a new one constructed from some other genus, *e.g.* *Trochosoidæ*, be adopted. The practical application of this view has led him to abandon such ong-established family-names as Epeiroidæ, Thomisoidæ, Attoidæ ; but if it were to be consistently and universally adopted, it is clear that all the family-names now in vogue, and every successive substitute, might have to be changed and again changed *ad infinitum*.

One other point deserving of notice is Dr. Thorell's opinion that the priority of *species*-names should be reckoned from 1751, when Linnæus, in his "Philosophia Botanica," proposed and gave rules for his binomial nomenclature. Most zoologists now refer back to 1758, the date of the publication of the tenth edition of the "Systema." But Linnæus's disciple Clerck published in 1757 his classical work "Aranei Suececi," in which he describes and gives good coloured figures of about sixty species of Swedish spiders, with binomial names according to Linnæus's system, and no arachnologist can admit that these names ought to be rejected simply because they were published *before* the tenth or twelfth edition of the "Systema." Such questions as these, however, we may perhaps leave with safety and confidence in the hands of the two recently appointed bibliographical committees, from which so much is expected. R. I. P.

COLOUR VISION.

Colour Vision: being the Tyndall Lectures delivered in 1894 *at the Royal Institution.* By W. de W. Abney, C.B., D.C.L., F.R.S. (late R.E.) Pp. ix. + 231, 8vo. (London: Sampson Low, Marston, and Co., 1895.)

CAPTAIN ABNEY has long been known as the authority upon the scientific measurement of colour, and his researches have naturally involved a continual attention to the problems of colour-vision. This, too, he has made the subject of measurement in numerous ways, and in observations extending over many years. The results of his work in the domain of colour-vision were systematically expounded by him in the "Tyndall Lectures" of 1894, and have now been recast in their present form. The volume, which is sumptuously printed in double-leaded type, is illustrated not only by numerous cuts and process-blocks, but by an excellent chromolithographic spectrum chart of the typical cases of colour-vision. It is worthy of the reputation of the President of the Physical Society, and constitutes a distinct addition to the literature of physiological optics.

The work, as published, is now arranged in chapters without reference to the original disposition of the subject-matter when delivered in the form of lectures ; and a very large portion of the book is devoted to the various cases of colour-blindness, both congenital and acquired, including the species of amblyopia due to excessive use of tobacco. In the opening chapter, which deals with the anatomy and physiology of the eye, the fascinating theory of the "visual purple" is mentioned, only to be at once dismissed as incompatible with the fact that that part of the retina which is most sensitive both to light and colour, the forea centralis, is destitute of the structures which alone contain the substance which possesses the purple reaction. The second chapter deals with the wave-lengths that correspond to the several colours of the spectrum, and with the apparatus devised by the author for producing any desired mixtures of spectrum tints for the purpose of colour-matching. The physical proofs that green is a primary colour because it cannot be made up by mixing any two other colours, and that yellow is not a primary because a yellow can be made by a mixture of two others, are given very clearly. On p. 24 the author remarks that "we are all familiar with the fact that there are three primary colours," whereas the fact is not that the colours are primary, but that the sensations are primary ; and he assumes, without any proof save that of indirect inference, that these primary sensations are three in number. Indeed, in another passage the admission seems to be made that the sensations which are primary are four in number.

Quoting from Prof. Michael Foster's epitome of Hering's theory of colour-vision, the author gives the following statement.

> "The sensations caused by different kinds of light, or by the absence of light, which thus appear to us quite distinct, and which we may speak of as 'native' or 'fundamental' sensations, are white, black, red, yellow, green, blue. Each of these seems to us to have nothing in common with any of the others, whereas in all other colours we can recognise a mixture of two or more of these. . . . Hering's theory attempts to reconcile, in some such way as follows, the various facts of colour vision with the supposition that we possess these six fundamental sensations. The six sensations readily fall into three pairs, the members of each pair having analogous relations to the other. In each pair the one colour is complementary to the other, white to black, red to green, and yellow to blue."

Commenting on this theory as so stated, Captain Abney says that it should be described as "tetra chromic" (should it not be chromatic?) rather than "tri-chromic," for as far as "colour" is concerned, the black-white sensation must be excluded But, surely